Appendix H

Conceptual Study of Centralized Instrumentation and Control System

H.1 General

The purpose of this report is to develop a conceptual design for a centralized monitoring and control system for the wells, pump stations and reservoirs within the transmission system of the Northern Governorates Water Authority (NGWA).

The transmission system is divided into two halves - the Eastern Transmission System and the Western Transmission System. The Eastern Transmission System starts with the Aqeb, Zatary, and Um Al Jemal well fields in the East. These well fields provide water to the Eastern Regional Operations Units (ROUs). The water is also pumped to the West to the reservoirs at the Hofa Pump Station. The Western Transmission System collects water from the Tabaqat Fahel, Manshiyeh, and Wadi Al Arab well fields in the West. The water from these well fields is pumped to the East to Irbid, and to the Hofa pump station and reservoirs where the West and the East Transmission Systems meet.

The proposed configuration for the monitoring and control system is shown below. The conceptual design provides a modular system that can be built up over time. A base system is required for communicating to the remote sites and to share the information at the Human Machine Interface (HMI) level. Once the base system is in place, additional sites can be added as time and budget permits. The sites can be prioritized so that the pump station sites can be implemented first and then followed by the wells, reservoirs and other sites that require manpower to monitor and control.

The following section describes the proposed system architecture, the methods of communication and the standard monitoring and control computers and PLCs. Standard designs are recommended for each given type of site (such as a pump station, well or reservoir). Thus, all well sites will monitor and control the same types of information for each well pump, and will monitor the discharge flow and pressure. The standard site signals, controls, and anticipated costs are described in following sections.

H.2 SCADA System Architecture

The goal of the instrumentation and control system for the well sites, pump stations, treatment plants, and reservoirs is to provide NGWA with the information about their system that is needed to support an informed decision making process. SCADA information will allow NGWA to operate the transmission systems more efficiently and to react to abnormal conditions quickly.

The conceptual SCADA system is designed to move data from the remote sites to a SCADA node for each ROU (Regional Operations Unit), providing first an area operations level of monitoring and control. The area operations will continue to be organized in geographical areas. The data can eventually be shared over an Ethernet network that would provide full access to the monitoring and control at NGWA headquarters. The Ethernet network is shown below in **Figure H-1** as a Wide Area Network (WAN). The ability to connect the area operations into one network depends on the ability to set up a WAN.

The system architecture drawing shown in **Figure H-1** does not show all of the remote sites. It is intended to be conceptual and illustrate the desired intent of the system. The primary

pump stations and well fields are included. Also the larger local systems that may partially feed the transmission system are shown. Most proposed reservoir sites have not been included at this time. During the detailed design these sites will be included.

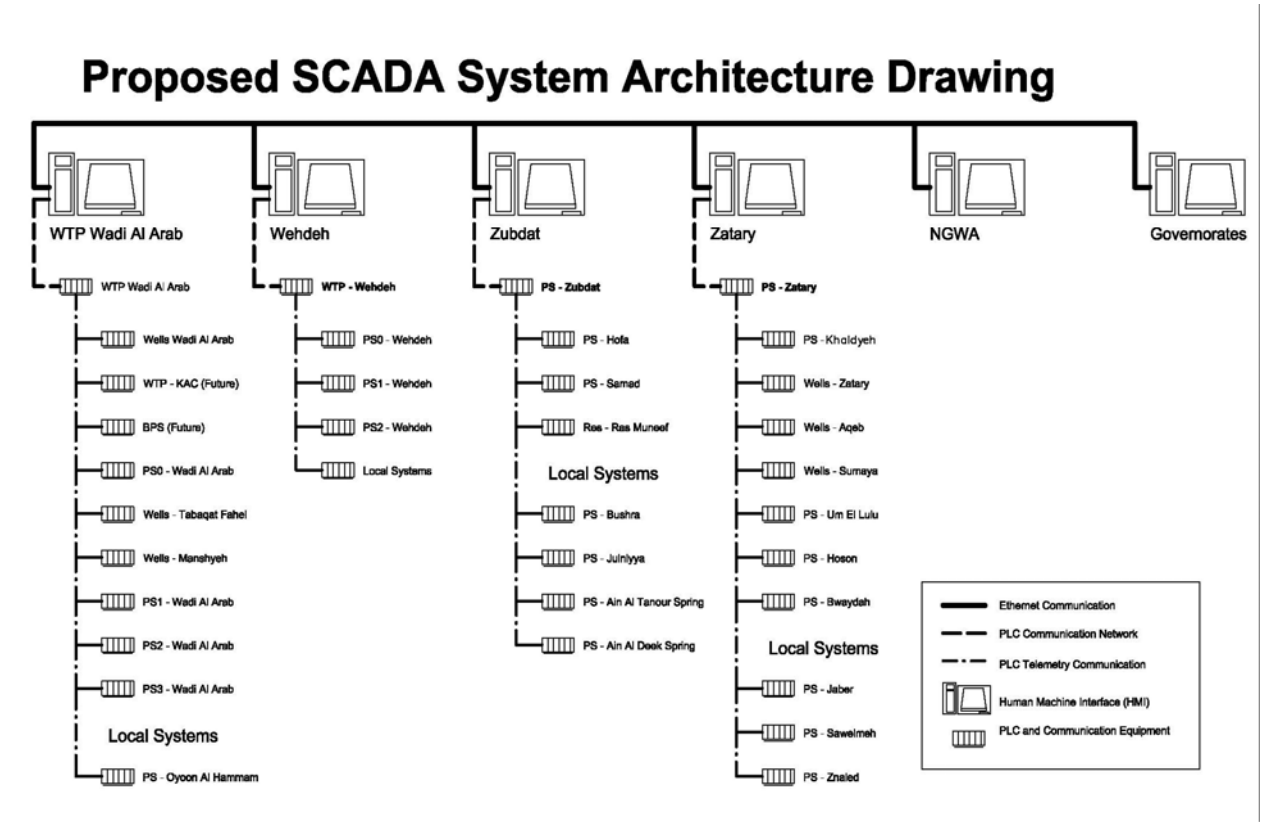


Figure H-1 Proposed SCADA System Architecture

The basic components of the instrumentation and control system are described below. These include the Human Machine Interface (HMI), Programmable Logic Controller (PLC), data communications, and Uninterruptable Power Supply (UPS).

H.2.1 Human Machine Interface (HMI)

To assure compatability and applicability of results, it is highly preferable that a single major Human Machine Interface (HMI) manufacturer supply all the HMI software for the transmission system. A further reason for specifying a single major HMI system is to minimize the risk of that system becoming obsolete and no longer being supported. The HMI software is not dependent on any one brand of personal computer hardware. It can run on any of the different hardware platforms. This open system approach helps to keep the overall system from becoming obsolete. These systems are also expandable so that it becomes very easy to add new monitoring and control sites. While it is desirable to have one PLC (Programmable Logic Controller) manufacturer, the preferred type of HMI system can communicate with PLCs from competing manufacturers.

The system configuration is arranged so that there will be area networks with an HMI node collecting data from the associated PLCs. A network of PLC data collection nodes will be formed, that provides a distributed database HMI system. The HMI network will be an

Ethernet based network. Once the ROU-area HMIs are networked, it will be possible to network the NGWA main office and any other Governorate or ROU office. Password security on the HMIs will be implemented so that a person can view and control equipment through the HMI for areas where they are responsible. Access for control of pumps and other equipment will be limited.

The estimated costs to install the HMI node at a Regional Operations Unit site is shown in **Table H-1.**

Table H-1 Estimated Cost, HMI Node at a Regional Operations Unit (ROU)

Operations Center	Materials Cost	Installation Cost	Site Total
PC	$ 5,000	$ 2,500	
HMI Software	$ 8,000	$ 2,500	
Communication Equipment	$ 10,000	$ 5,000	
RTU/PLC	$ 5,000	$ 2,500	
RTU Panel/Misc	$ 5,000	$ 2,500	
Contractor labor costs - design, submittals, testing, and commissioning		$ 10,000	
Sub-Total	$ 33,000	$ 25,000	$ 58,000
Contingency (25%)			$ 14,500
Total Costs			$ 72,500

High-speed communication among HMI nodes is necessary. The phone company can install a high speed phone connection. The radio cell phone company Xpress has indicated that they have the capability to supply a high speed connection (at Ethernet speeds), but as of today they have not implemented such a system.

H.2.2 Programmable Logic Controller (PLC)

The PLCs should preferably be from a single major manufacturer of PLCs. Although it is impossible to guarantee that a manufacturer will not go bankrupt or stop supporting their PLCs, a larger major manufacturer is less likely to create such problems. The older Wadi Al Arab pump stations have had good service from the PLCs at those sites. Unfortunately the PLCs are now obsolete. The PLCs in the newer Wadi Al Arab pump stations are quite new, but are also now obsolete. Additional problems with the PLCs are that NGWA does not have the programming software so they are not able to troubleshoot problems or make modifications to the programs.

The PLCs should also be from a compatible family of PLCs, such that the master-communication PLC at the Area control center is simply a larger PLC than the PLCs at remote pump stations. Similarly, the PLCs at the well sites and reservoir sites can be smaller versions of those found at pump stations. The master communication PLC will control the equipment at the regional operations site, and will also collect data from the other PLCs in that area. The data will be communicated among the PLCs using the standard communication protocols of the selected manufacturer. The master communication PLC will store the current data for the HMI to display. The PLCs at the remote sites will monitor

and control the equipment at those sites and organize the data to optimize communication with the master PLC.

Through use of standardized PLC programs, each well site will use the same layout of signals and the same software as other well sites. This will aid anyone who is trying to troubleshoot a problem at a site. In addition, the PLC programs for all sites will be written with the same software so it will not be necessary to know how to program multiple PLCs. By using standardized PLCs, it will also be possible to reduce the amount of spare parts (Input/Output modules, etc.) that NGWA will be required to have in order to remedy any problems with their system.

H.2.3 Data Communications

Several commercial data communications systems are available in Jordan: standard telephone lines, radio communications, cell phones and two-way radios.

Standard land-based phone lines will work where they are available. However, most sites do not have phone lines installed and it would be too costly to have them installed. Phone lines are an option, however, to connect the ROU control centers into a NGWA-wide Ethernet network. NGWA recently encountered a problem in phone-line communications in the vicinity of Wadi Al Arab PS0, where road construction damaged the communication cable. There is a dispute as to who should repair the cable, and it has not been repaired for several months.

Use of radio communications in Jordan would require obtaining a license for use of assigned radio frequencies. In this study, discussions on radio licensing were held with the Telecommunications Regulatory Commission in Amman. This agency is responsible for assigning frequencies and licensing. Radio frequencies are available in the 430 to 470 MHz range with bandwidths of 25 KHz. If the Commission is provided with the GPS coordinates and elevations of the sites to be served, the Commission is willing to provide an unofficial radio survey. They have good contour maps. The downside of a radio system is that the cost of a license is 151 JD per year per site. The cost per site is the same even if all sites will use the same frequencies. There is no quantity discount for licensing a large number of sites or frequencies. Another disadvantage of radios, at present, is that they do not have the capability of allowing Ethernet communications over the radio. A different communication method would be necessary for the ROU control HMIs to share data.

Cell phones and cell phone modems are an alternative that should be investigated in more detail at the time of final design. Prices for use of cell phones are declining rapidly and competition is increasing in Jordan; also, the availability of service at remote mountainous locations is constantly improving. At present the cost per message for the two cell phone carriers in Jordan is relatively high, but this may change in the next few years. The data communication system capabilities of the cell phone companies may also improve substantially in the future.

The fourth means of data communications explored in this study is the Xpress company radio telephone system. It is a system similar to cell phones, except that it provides two-way radio communications similar to that of walkie-talkies. Xpress company has communications infrastructure in the northern governorates, and they may be willing to provide the type of network envisioned for the control system architecture. The requirements of this project are within their capabilities. However, as a company Xpress needs to review the project to determine if they want to provide this type of service.

H.2.4 Uninterruptible Power Supply (UPS)

Each site should have a UPS for the control system. NGWA has had problems at time with losing power for short periods. A UPS will keep the PLC at that site operating. When power is restored, the PLC can be programmed to restart the equipment that was running prior to the power outage or it can be programmed to wait for a command from the Area Control HMI to start equipment. Additionally, a UPS will allow the master site and the HMI system know that there is a potential problem with power at that site. (The costs for UPSs are included with the site costs.)

H.3 Monitoring and Control Sites

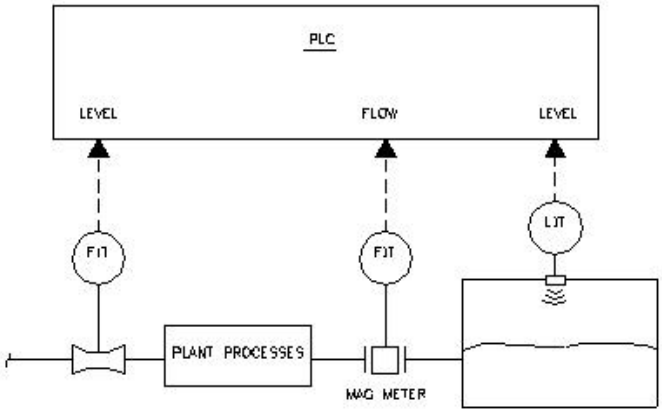
H.3.1 Water Treatment Plants

Automated monitoring and operation of the water treatment plants is not addressed in this report; the intent here is to target the need for coordinated operation of wells, pump stations and treatment plants. In general, status information concerning water plant production will be brought into the SCADA system to support decisions on pumping operations.

Each water treatment plant will include a PLC, which will be used to monitor and transmit the following data to the SCADA system:

- Water flow into the plant
- Water flow out of the plant
- Finished water reservoir level

The following is the Process and Instrumentation Diagram (P&ID) for the standard treatment plant monitoring and control design for the SCADA system.



The estimated cost to install a monitoring and control system at one treatment plant site is shown in **Table H-2**.

Table H-2 Estimated Cost, Instrumentation and Control at a Water Treatment Plant

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 3,500	$ 2,500	
Communication Equipment	$ 3,000	$ 1,500	
Parshall Flume PIT	$ 2,000	$ 1,000	
Flow meter	$ 18,000	$ 9,000	
Reservoir Level, ultrasonic	$ 2,000	$ 1,000	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 10,000	
Sub-Total	$ 28,500	$ 25,000	$ 53,500
Contingency (25%)			$ 13,375
Total Costs			$ 66,875

H.3.2 Pump Stations

Usually, each pump station will draw water from a nearby suction reservoir, and pump water to a reservoir at a higher elevation. The conceptual design encompasses monitoring of pump remote/local control switch positions, run status, and pump start/stop control output. Where possible, the design will include monitoring of pump alarm conditions. If it is not possible to monitor an alarm condition, the PLC logic will be implemented to generate an alarm. The run request command and the run status shall be compared when the pump Remote/Local switch indicates Remote. If the two signals are in disagreement for more than 10 seconds, an alarm shall be generated and the control output signal shall be turned to off. When the pump is in Local, the operator at the pump station has control of the pump and no alarm will be generated.

When the pumps are in Remote control, the operator at the ROU Area Control Center will be able to start and stop pumps at the pump station. The pumps can be automatically started based on reservoir levels or pump station line pressure, but NGWA may want to implement automatic operation initially on a pilot basis only. The pressure on the discharge of the pump station will be monitored. If the pressure exceeds a high limit, an alarm will be generated to notify the operator. If the pressure rises to a second higher level, another alarm will be generated and the pumps at the pump station will be stopped automatically.

Each water pump station will need a new PLC, and a radio or cell phone with modem will also be required for data communications.

The following information will be monitored or controlled for each pump:

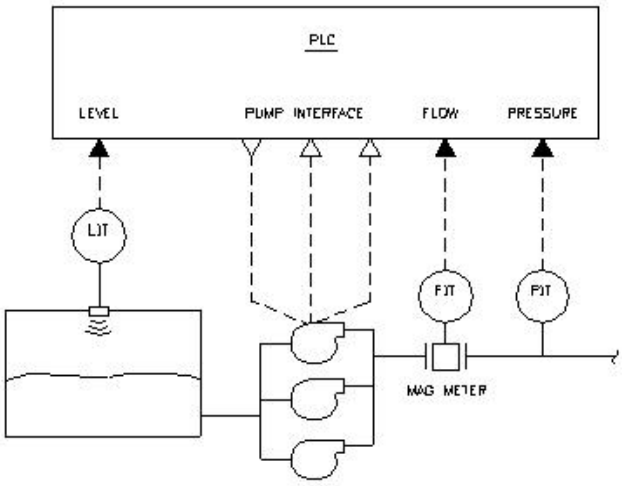
- Pump Remote/Local status
- Pump Failure alarm
- Pump Run status
- Pump Run command

The following information will be monitored at each pump station:

- Station door open/intrusion alarm
- Station reservoir level (and software generated high and low alarms)

- Station discharge flow (and software generated high flow alarm)
- Station line power
- Control system Uninterruptible Power Supply (UPS) status
- Station discharge pressure (and software generated high and low alarms). If there are multiple discharge lines, there will be one pressure transmitter on each line

The following is the Process and Instrumentation Diagram (P&ID) for the standard pump station monitoring and control design.



The estimated cost to install a monitoring and control system at a typical pump station is shown in **Table H-3**.

Table H-3 Estimated Cost, Instrumentation and Control at a Pump Station

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 3,500	$ 2,500	
Communication Equipment	$ 3,000	$ 1,500	
Flow meter 600 mm mag	$ 16,000	$ 8,000	
Reservoir Level, ultrasonic	$ 4,000	$ 2,000	
Pumps interface	$ 1,200	$ 3,000	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 10,000	
Sub-Total	$ 27,700	$ 27,000	$ 54,700
Contingency (25%)			$ 13,675
Total Costs			$ 68,375

H.3.3 Wells

The well sites typically have one well pump, which delivers water into a transmission line or to a nearby well-field pump station or local distribution reservoir. The operator at the ROU Area Control Center will be given the capability to start and stop the well pumps. Typically the well pumps are started and then left running for an extended period of time. The

minimum level of monitoring and control for the pumps is to monitor their Remote/Local control switch positions, monitor their run status, and provide a start/stop control output. Where possible, the design will include monitoring of pump alarm conditions. If it is not possible to monitor an alarm condition, the PLC logic will be implemented to generate an alarm. In general, the run request command and the run status shall be compared when the pump Remote/Local switch indicates Remote. If the two signals are in disagreement for more than 10 seconds, an alarm shall be generated and the control output signal shall be turned to off. When the pump is in Local, the operator at the well site has control of the pump and no alarm will be generated. There are two additional monitored and alarmed signals. The flow from the well pump will be monitored. If the pump is running and there is no flow, this condition will be alarmed and the well pump will be stopped if it is Remote control. Similarly, the discharge pressure from the well pump will be monitored. If the well pump is running and the discharge pressure drops below a minimum value, the condition will be alarmed and the well pump will be stopped if it is in Remote control.

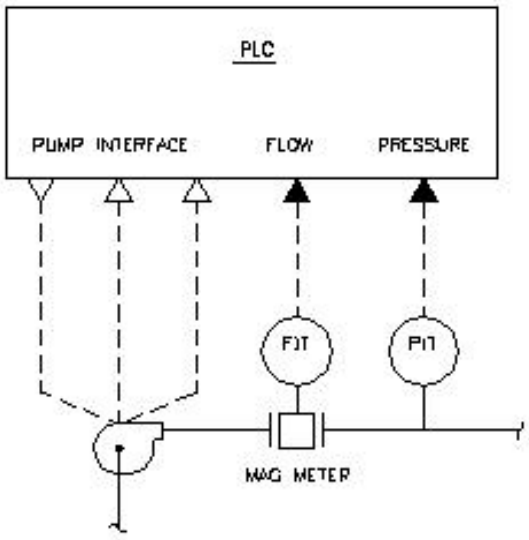
A PLC will be installed at each well, and a radio or cell phone for data communications. The following information will be monitored for each well pump:

- Pump Remote/Local status
- Pump Failure alarm
- Pump Run status
- Pump Run command

At the well sites, the following information will also be monitored:

- Station door open/intrusion alarm
- Well flow (and software generated high and low alarms)
- Well discharge pressure (and software generated high and low alarms)
- Station line power
- Control system Uninterruptible Power Supply (UPS) status

The following is the Process and Instrumentation Diagram (P&ID) for the standard well site monitoring and control design.



The estimated cost to install a monitoring and control system at one well site is shown in **Table H-4**.

Table H-4 Estimated Cost, Instrumentation and Control at a Well

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 3,500	$ 1,750	
Communication Equipment	$ 3,000	$ 1,500	
Flow meter 100 mm mag	$ 3,000	$ 1,500	
Discharge Pressure	$ 2,000	$ 1,000	
Pumps interface	$ 500	$ 250	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 6,000	
Sub-Total	$ 12,000	$ 12,000	$ 24,000
Contingency (25%)			$ 6,000
Total Costs			$ 30,000

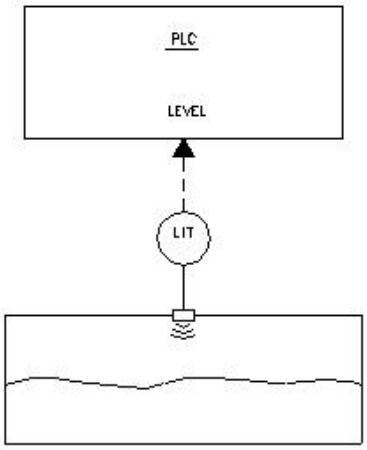
H.3.4 Reservoirs

Filling and emptying of distribution reservoirs will be monitored, since this information is necessary to control the pumps that deliver the water to the reservoirs. The reservoir water level will be monitored and compared in software to high and low limits. If these limits are exceeded, high or low level alarms will be generated. Some reservoir sites will have flow meters and flow control valves. These will be used when several reservoirs at different elevations are fed by a single pump station. The flow control valve will regulate the flow into the reservoir to avoid high velocities in the force main, and to limit the required capacity of the pump station. The flow control valve will need to open and close slowly to limit surge pressures and to avoid "hunting" or over-compensation to transient changes in flow and pressure.

Each reservoir site will need a small PLC, and a radio or cell phone with modem for data communications. At a reservoir site, the following information will be monitored:

- Access door open/intrusion alarm
- Reservoir level (and software-generated high and low alarms)
- Line power and status of mechanized flow-control valve
- Status of Uninterruptible Power Supply (UPS)

The Process and Instrumentation Drawing (P&ID) for the standard reservoir monitoring and control design is shown below:



The estimated cost to install the monitoring and control system at a typical reservoir site is shown in **Table H-5**.

Table H-5 Estimated Cost, Instrumentation and Control at a Distribution Reservoir

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 2,000	$ 750	
Communication Equipment	$ 3,000	$ 1,500	
Reservoir Level, ultrasonic	$ 2,000	$ 1,000	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 3,500	
Sub-Total	$ 7,000	$ 6,750	$ 13,750
Contingency (25%)			$ 3,438
Total Costs			$ 17,188

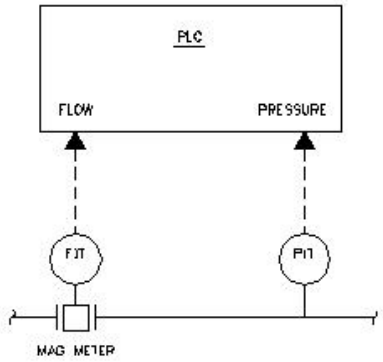
H.3.5 Flow Metering Sites

The NGWA system contains about 50 locations where flows or pressures are monitored, and used to assist in system operations, and to compute the water balance for imports/exports and for UFW computations. The requirements for monitoring and control at flow metering sites are similar to those for Reservoir sites. Software alarms will be generated when the site pressure exceeds high or low limits or when the flow exceeds a high limit.

Each monitoring sites will need a small PLC, and a radio or cell phone for data communications. At the flow/pressure monitoring sites, the following information will be monitored:

- Site panel door open/intrusion alarm
- Monitored pressure and/or flow (and software-generated high and low alarms)
- Station line power
- Status of control-system Uninterruptible Power Supply (UPS)

The following is the Process and Instrumentation Diagram (P&ID) for the standard flow metering site monitoring and control design.



The estimated cost to install the monitoring and control system at one flow metering site is shown in **Table H-6**.

Table H-6 Estimated Cost, Instrumentation and Control at a Flow/Pressure Monitoring Site

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 2,000	$ 750	
Communication Equipment	$ 3,000	$ 1,500	
Flow meter 200 mm mag	$ 8,000	$ 4,000	
Pressure monitoring	$ 2,000	$ 1,000	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 5,000	
Sub-Total	$ 15,000	$ 12,250	$ 27,250
Contingency (25%)			$ 6,812
Total Costs			$ 34,062

H.3.6 System Isolation Valves

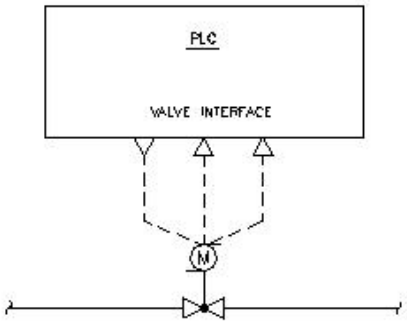
Isolation valves are used in rationing water to portions of the service area of a given distribution reservoir. Isolation valves are currently operated to give customers water on one day of each week. NGWA would benefit from the ability to remotely open and close these isolation valves.

Each isolation-valve site would need a small PLC, and a radio or cell phone for data communications. all need small PLCs. The following information would be monitored:

- Site panel door open/intrusion alarm
- Valve status (open or closed)
- Control-valve position (if flow is throttled)
- Station line power

- Status of control-system Uninterruptible Power Supply (UPS)

The following is the Process and Instrumentation Diagram (P&ID) for the standard system isolation-valve design for the SCADA system.



The estimated cost to install the monitoring and control system at one system isolation valve site is shown in **Table H-7**.

Table H-7 Estimated Cost, Instrumentation and Control at an Isolation Valve Site

Item	Materials Cost	Installation Costs	Site Total
RTU/PLC	$ 1,500	$ 750	
Communication Equipment	$ 3,000	$ 1,500	
Valve interface	$ 500	$ 500	
Contractor labor costs - design, submittals, testing, programming and commissioning		$ 2,000	
Sub-Total	$ 5,000	$ 4,750	$ 9,750
Contingency (25%)			$ 2,438
Total Costs			$ 12,188

H.4 Instrumentation

H.4.1 General

Instrumentation should be standardized within the NGWA system, to reduce the cost to maintain spare parts, as well as to reduce training requirements, and to simplify maintenance and calibration requirements. The types of instruments required are described below.

H.4.2 Magnetic Flow Meters

At several of the newer sites, Endress & Hauser magnetic flow meters have been installed in the NGWA system. Mag flow meters are good in this application since there is minimal head loss through them and they are very accurate. Individual installations will need to be reviewed during the detailed design phase to verify that the proper lengths of straight pipe runs are provided upstream (10 pipe diameters) and downstream (5 pipe diameters) of the meters. The NGWA maintenance people are satisfied with the E&H mag meters, and hence these could be adopted as the NGWA standard for future installations.

H.4.3 Ultrasonic Water-Level Transmitters

Some of the NGWA reservoirs contain Endress & Hauser ultrasonic level transmitters. Ultrasonic level transmitters work well in reservoirs. During the final design, care must be taken with the installation locations so that they are not installed too close to a wall. Ultrasonic level transmitters have a 15 degree cone through which the ultrasonic wave passes. Any walls or other obstructions will cause a false echo and a false water-level reading. Special meters can be specified that will reduce the cone angle if necessary. The E&H level transmitters are working well and the maintenance staff are happy with them; hence NGWA may decide to standardize on this transmitter.

H.4.4 Pressure Transmitters

Similar to the flow meters and the water-level transmitters, NGWA should standardize on one pressure transmitter. This keeps necessary spare parts and training to a minimum. Other CDM clients have reported good performance by E&H Pressure transmitters, and hence these are recommended for adoption as the NGWA standard.

H.5 Summary and Conclusions

The conceptual design described in this study is based on open-architecture devices, rather than the proprietary closed architecture of a single vendor. Although we recommend utilizing equipment from only major product vendors, the selection of open-architecture devices means that the design and future implementation is not dependent on a single vendor. If a product becomes obsolete, it will be possible to replace it with an equal product without needing to replace all of the devices that have been previously installed.

The costs to implement the design are incremental in nature. It is not necessary to include all sites immediately. They can be added as they are built or as the information from a site becomes more critical. For this reason, the cost estimates are based on a typical site for each of the different types. For example if three well sites will be added to the overall system, the costs would be 3 times the cost of one well site. The cost estimates include an estimate for the Engineering design and a 25% contingency allowance, which is the industry standard for the probable cost estimate at the conceptual design phase. Any number of the different types of sites can be included in the system, with the exception of the Operations Centers. There needs to be one Operations Center to coordinate the communications within each area designated on Figure 2.1, which shows the proposed SCADA system architecture. However, once there is at least one Operations Center within each ROU, there can be any number of additional Operation Centers, such as at NGWA headquarters, which are only used to monitor the data.

The estimated cost for each type of site to be monitored and controlled is summarized in **Table H-8.**

Table H-8 Summary of Estimated Costs by Type of Site

Type of Site	Estimated Site Cost
Operations Center	$ 72,500
Water Treatment Plant (SCADA only)	$ 66,875
Pump Station	$ 68,375
Well Site	$ 30,000
Reservoir Site	$ 17,188
Flow Metering Site	$ 34,062
System Isolation Valve	$ 12,188

Appendix I

Estimated Costs, Alternative Transmission Systems

Table I-1a: Cost Estimates for Alternative 1 - Reservoirs

ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
WA-PS3	**Wadi Al Arab PS3**				**4667**	**2680**	**7346**	**Exist 1700**		
								6000	**917,672**	
DS02IR-1	Deir Al Saneh	WA-PS3	643	1071	178		1892	2000	461,835	89.3
DS01IR-1	**Qumaym**	**WA-PS3**	**1784**	**2973**	**810**	**630**	**6196**	**6000**	**917,672**	**247.7**
DS03IR-1	Al Taybeh	WA-PS3	748	1247	208		2204	2000	461,835	103.9
DS04IR-1	Mindah	WA-PS3	688	1146	40		1874	2000	461,835	95.5
DS05AK-11	**Jenin**	**WA-PS3**	**315**	**524**	**292**	**410**	**1541**	**1500**	**385,833**	**43.7**
DS10AK-1	Tubneh		373	621	103		1097	1000	299,463	51.8
DS06AK-1	Ezimal	DS05AK-11	688	1146	205		2039	2000	461,835	95.5
DS08AK-1	Dair Abi Said		1149	1915	320		3384	4000	712,246	159.6
DS09AK-1	**Kufur Alma**	**WA-PS3**	**708**	**1180**	**1088**	**1783**	**4760**	**5000**	**818,840**	**98.4**
DS11AK-1	Al Ashrafiyya High	DS09AK-1	877	1461	243		2582	3000	595,036	121.8
DS12AK-1	Al Ashrafiyya low	DS09AK-1	347	578	97		1021	1000	299,463	48.1
DS13AK-1	Kufur Awan	DS09AK-1	1037	1728	288		3053	3000	595,036	144.0
DS07AK-1	Kufur Kifia WT	DS05AK-11	47	79	13		139	500	518,258	6.6
ZE01IR-1	**Zubdat**		**19134**	**31890**	**4918**	**15934**	**71877**	**Existing 110000**		**2657.5**
ZE02IR-1	Kufur Youba	WA-PS3	508	846	142		1495	1500	385,833	70.5
ZE03IR-1	Jamha	DS01IR-1	91	151	25		267	250	125,909	12.6
ZE04IR-1	Soum	DS01IR-1	615	1026	290		1931	2000	461,835	85.5
ZE05IR-1	Jijeen	DS01IR-1	565	942	38		1546	1500	385,833	78.5
ZE06IR-1	Sal	WE-PS2	1978	3297	550		5825	6000	917,672	274.8
ZE06IR-2	Sal WT	WE-PS2	1177	1962	327		3465	500	518,258	163.5
	Sal WT Supplementary Reservoir							3000	595,036	
ZE07IR-1	Al Mughayyir	WE-PS2	498	831	138		1467	1500	385,833	69.2
ZE08IR-1	Foua'ra	WE-PS2	532	887	148		1568	1500	385,833	73.9
ZE09IR-1	Beit Ras	WE-PS2	1573	2622	437		4631	5000	818,840	218.5
ZE10BK-1	**Sama Arrousan**	**WE-PS2**	**2533**	**4221**	**1427**	**1447**	**9627**	**10000**	**1,262,824**	**351.8**
ZE11BK-1	Safouk WT	ZE10BK-1	233	389	65		687	500	518,258	32.4
ZE12BK-1	Durama	ZE10BK-1	599	998			1596	1500	385,833	83.1
ZE13BK-1	Hartha	ZE10BK-1	1005	1675			2680	3000	595,036	139.6

Table I-1a: Cost Estimates for Alternative 1 - Reservoirs - Continued

ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE14BK-1	Saham	ZE10BK-1	761	1269			2030	2000	461,835	105.8
ZE15O-1	Edoun	ZE16IR-1	1747	2912			4658	5000	818,840	242.6
ZE16IR-1	**Hofa**		**1573**	**2622**	**4872**	**2646**	**11713**	**Existing 12000**		**218.5**
ZE17O-1	Sareeh	ZE16IR-1	128	213			341	350	155,377	17.8
ZE18IR-1	Ham	ZE16IR-1	167	278			445	500	194,178	23.2
ZE19IR-1	Beit Yafa	ZE01IR-1	632		175		807	1000	299,463	87.8
ZE20IR-1	Deir Yousef		285	476	80		841	1000	299,463	39.6
ZE21IR-1	Juhfiyya	ZE16IR-1	181	302	50		532	500	194,178	25.1
ZE22IR-1	Habaka	ZE16IR-1	226	377	63		667	750	250,182	31.4
ZE23O-1	Al Hoson	ZE16IR-1	2179	3632	605		6416	7000	1,010,483	302.6
ZE24IR-1	**Samad**	**ZE16IR-1**	**138**	**230**	**2578**	**443**	**3390**	**3000** **Existing 550**	**595,036**	**19.2**
ZE25O-1	Shatana	ZE24IR-1	10	16			26	100	71,014	1.3
ZE29IR-1	Dair Al Birak	ZE24IR-1	47	78	13		138	150	91,496	6.5
ZE30IR-1	Almazar	ZE24IR-1	717	1195			1911	2000	461,835	99.5
ZE31IR-1	Ibya		318	530	88		936	1000	299,463	44.1
ZE32IR-1	E'nbeh		435	725	117		1276	1500	385,833	60.4
ZE33AJ-1	**A'seem 4**	**ZE24IR-1**	**27**	**45**	**825**	**1637**	**2534**	**3000**	**595,036**	**3.8**
ZE34AJ-1	Sana'ar	ZE33AJ-1	112	187			298	350	155,377	15.5
ZE35IR-1	Erhaba	ZE33AJ-1	689	1149			1838	2000	461,835	95.7
ZE36AJ-1	**Ras Muneef**	**ZE24IR-1**	**1081**	**1801**	**1500**	**1836**	**6218**	**Existing 6300**		**150.1**
ZE37AJ-1	Rasoun	ZE33AJ-1	121	201	10		332	350	155,377	16.8
ZE38AJ-1	Arjan		341	568	95		1004	1000	299,463	47.3
ZE39AJ-1	Ba'oon		330	550	92		971	1000	299,463	45.8
ZE40AJ-1	**Sakhra**	**ZE36AJ-1**	**481**	**802**		**563**	**1846**	**2000**	**461,835**	**66.8**
ZE41JE-1	Kufr Khal	ZE40AJ-1	554	923			1477	1500	385,833	76.9
ZE42JE-1	Souf Down	ZE36AJ-1	726	1211			1937	2000	461,835	100.9
ZE43JE-1	Souf Up	ZE36AJ-1	429	715	67		1210	1500	385,833	59.5
ZE45JE-1	Raymun	ZE36AJ-1	429	716			1145	1000	299,463	59.6
ZE50JE-1	Hooneh	ZE33AJ-1	102	171			273	350	155,377	14.2

Table I-1a: Cost Estimates for Alternative 1 - Reservoirs - Continued

ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE51JE-1	Sakeb	ZE36AJ-1	725	1209			1934	2000	461,835	100.7
ZE52JE-1	Al Husayniyyat	ZE36AJ-1	41	68			108	Existing 675		5.6
ZE53JE-1	Jabal Akhdar	ZE33AJ-1	50	83			132	150	91,496	6.9
ZE54AJ-1	Mazraat Eshkarah	ZE33AJ-1	129	215	37		381	500	194,178	17.9
ZE55AJ-1	Ajloun	ZE33AJ-1	571	952			1523	1500	385,833	79.3
ZE56AJ-1	Ishtafina	ZE33AJ-1	39	66			105	Existing 100		5.5
ZE57AJ-1	Dair Smadiyeh	DS09AK-1	120	201	33		354	350	155,377	16.7
ZE58AJ-1	Al Hashemiah	DS09AK-1	806	1344	223		2373	3000	595,036	112.0
ZE59AJ-1	Ain Jana	ZE33AJ-1	629	1048	18		1694	2000	461,835	87.3
ZE60AJ-1	Anjarah Down	ZE33AJ-1	729	1216			1945	2000	461,835	101.3
ZE61AJ-1	Anjarah Up	ZE36AJ-1	717	1195			1911	2000	461,835	99.5
ZE62AJ-1	Kofranjeh Down	DS09AK-1	803	1338	223		2364	3000	595,036	111.5
ZE63AJ-1	Kofranjeh Up	DS09AK-1	592	987	165		1743	2000	461,835	82.2
RA01RA-1	Ramtha-JUST	ZA01MA-1	190	317	53		560	500	194,178	26.4
RA02RA-1	**Ramtha City**	**ZE01IR-1**	**4406**		**1800**	**1153**	**7359**	**8000**	**1,098,434**	**611.9**
RA03RA-1	Al Toura	RA02RA-1	1027		132		1159	1500	385,833	142.7
RA04RA-1	Ash Shajara	RA02RA-1	1027				1027	1000	299,463	142.7
RA05RA-1	Emrawa & Ath Thunayba	RA02RA-1	790		82		872	1000	299,463	109.7
RA06RA-1	Al Bowayda	ZA01MA-1	415	692	115		1223	1500	385,833	57.7
JE03JE-1	Qafqafa	ZE40AJ-1	300	501			801	1000	299,463	41.7
JE04JE-1	Thugrat Asfoor	ZE40AJ-1	10	17			28	100	71,014	1.4
JE07JE-1	Muqbla	ZE40AJ-1	151	252			403	500	194,178	21.0
WE-PS2	**Wehdeh PS2**					**3846**	**3846**	**4000**	**712,246**	
ZE44JE-1	Dair Al liyyat	UL08MA-1	439	732			1171	1500	385,833	61.0
ZE47JE-1	Nahla	UL08MA-1	53	88			141	150	91,496	7.3
ZE49JE-1	Burma UP	UL08MA-1	184	307			490	500	194,178	25.5
ZE48JE-1	Burma down	UL08MA-1	419	699			1118	1000	299,463	58.3
ZE46JE-1	Ketta	UL08MA-1	726	1210			1935	2000	461,835	100.8
ZE28O-1	Kitim	UL04MA-1	364	607	102		1072	1000	299,463	50.5
ZE26O-1	Nuaimeh down	UL04MA-1	392	653	108		1152	1000	299,463	54.4

Table I-1a: Cost Estimates for Alternative 1 - Reservoirs - Continued

ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE27O-1	Nuaimeh up	UL04MA-1	421	702	117		1240	1500	385,833	58.5
ZA01MA-1	**Zatary**		**472**	**786**	**7252**	**633**	**9143**	**Existing 10000**		**65.5**
ZA03MA-1	Sarhan		747	1245	208		2201	2500	530,952	103.8
ZA05MA-1	**Mafraq**		**3689**	**6148**	**1190**	**330**	**11358**	**12000**	**1,415,243**	**512.4**
ZA06MA-1	Hayyan	ZA05MA-1	304	506	85		895	1000	299,463	42.2
ZA07MA-1	**Khalidiyya**		**1340**	**2234**	**420**	**97**	**4091**	**4000**	**712,246**	**186.1**
ZA08MA-1	Thugrat AlJubb	ZA07MA-1	175	292	48		516	500	194,178	24.3
ZA02MA-1	Baej	ZA01MA-1	707	1179	197		2083	2000	461,835	98.2
ZA03MA-2	Jabir		404	674	112		1189	1500	385,833	56.1
LM01MA-1	As Suwaylima		166	276	47		488	500	194,178	23.0
ZA04MA-1	Hamra		596	994	210		1800	2000	461,835	82.8
UL14MA-1	Az Zannieh WT		161	268	45		475	500	518,258	22.4
UL12MA-1	Hameed	ZA05MA-1	31	51	8		90	Existing 130		4.3
UL10MA-2	Rhab WT	UL04MA-1	128	213	35		376	500	518,258	17.8
UL10MA-1	Qadem	UL04MA-1	154	256	43		453	Existing 500		21.3
UL05MA-1	Buwayda WT	UL04MA-1	107	179	30		316	500	518,258	14.9
UL02MA-1	Um Neam	UL01MA-1	283	471	78		832	1000	299,463	39.3
UL11MA-1	Mo'ammariyeh	ZA05MA-1	204	339	57		599	750	250,182	28.3
UL13MA-1	Balama	ZA05MA-1	796	1327	222		2345	2500	530,952	110.6
UL15MA-1	Mazra'a		349	581	97		1026	1000	299,463	48.4
UL06MA-1	Dajaniyya	UL04MA-1	229	381	63		673	750	250,182	31.8
UL04MA-1	**Buwayda**	**UL01MA-1**	**0**	**0**	**1678**	**2126**	**3805**	**4000**	**712,246**	**0.0**
UL03MA-1	Bani Hasan	UL01MA-1	631	1051	175		1857	2000	461,835	87.6
UL09MA-1	Nadira	UL08MA-1	155	258	615		1027	1000	299,463	21.5
UL01MA-1	**Um El Lulu**	**ZA01MA-1**	**360**	**600**	**2032**	**507**	**3498**	**Existing 550** **3000**	**595,036**	**50.0**
JE05JE-1	Majar	UL08MA-1	232	386			618	750	250,182	32.2
JE09JE-1	Jerash Down	UL04MA-1	1328	2213	267		3807	4000	712,246	184.4
JE06JE-1	Jerash Up	UL04MA-1	756	1261			2017	2000	461,835	105.1

Table I-1a: Cost Estimates for Alternative 1 - Reservoirs - Continued

ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
JE08JE-1	Souf Ref. Camp	UL04MA-1	836	1393			2228	Existing 750 1500	 385,833	116.1
JE02JE-1	Balila	UL04MA-1	362	604	100		1067	1000	299,463	50.3
JE01JE-1	Musherfa	UL04MA-1	187	312	53		553	500	194,178	26.0
UL07MA-1	Hamama	UL04MA-1	95	159			254	250	125,909	13.2
UL08MA-1	**Midawar**	**UL04MA-1**	**111**	**185**	**30**	**1230**	**1555**	**1500**	**385,833**	**15.4**
	Total Cost, $								**48,763,727**	

* V2 of the concerned reservoirs has been considered in the existing Zabda reservoir

** The reservoir taking care of the V4

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Um El-Lulu	1	300	220					Not to be used	0	0	
	2	380	265					Not to be used	0	0	
	3	300	250					Not to be used	0	0	
	4	300	350					Not to be used	0	0	
					47	83	To Um Naam	New	32,480	18	11425
					1112	132	To Bwaydah P.S	New	768,455	677	429899
Bwaydah P.S	1	50	250					Not to be used	0	0	0
	2	60	250					Not to be used	0	0	0
	3	75	200					Not to be used	0	0	0
	4	100	200					Not to be used	0	0	0
					258	99	Jerash	New	178,293	118	74807
					38	24	Qadam	New	26,260	4	2671
Zatary P.S	1	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Use Existing	0	500	317550
	2	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Use Existing	0	500	317550
	3	380	265	To Um El-Lulu P.S	380	265	To Um El-Lulu P.S	Use Existing	0	440	279444
	4	380	265	To Um El-Lulu P.S	380	265	To Um El-Lulu P.S	Stand by	0	0	0
	5	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Stand by	0	0	0

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Zatary P.S	6	500	100					Not to be used	0	0	0
	7	500	117					Not to be used	0	0	0
	8	128	100					Not to be used	0	0	0
	9	500	100					Not to be used	0	0	0
	10	500	100					Not to be used	0	0	0
	11	128	100					Not to be used	0	0	0
					2863	236	Extra Pumping Capacity to Um El-Lulu	New	1,978,496	3116	1978888
					29	156	To Baej	New	20,041	21	13250
Khaldiyeh P.S					29	95	To Thughret Al-Jubb	New P.S	20,041	13	8093
Mafraq P.S					99	212	To Hayan and Moammariyeh Line	New P.S	68,415	97	61420
Midwar P.S					369	135	To Nadira and Jerash	New P.S	255,000	229	145422

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS0	1	625	320	To PS1				Not to be used	0	0	0
	2	625	320	To PS1				Not to be used	0	0	0
	3	625	320	To PS1				Not to be used	0	0	0
					675	136	Booster TF to PS1	New Pumps	466,463	423	268863
					600	257	KAC Water to PS1	New Pumps	414,634	711	451619
Wadi Al Arab PS1	1	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355656
	2	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355656
	3	576	235	To PS2	576	235	To Wadi Al Arab PS2	Stand By	0	0	0
	4	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317550
	5	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317550
	6	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317550
	7	567	220	To PS2	567	220	To Wadi Al Arab PS2	Stand By	0	0	0
Total required flow from PS1 to PS2 equal 2800m^3/h											

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS2	1	666	250	To PS3	666	250	To Wadi Al Arab PS3	Use Existing	0	675	428693
	2	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	3	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	4	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317550
	5	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317550
	6	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317550
	7	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317550
Total required flow from PS2 to PS3 equal 2800m^3/h											

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS3	1	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428693
	2	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428693
	3	666	250	To Zubdat	666	250	To Zubdat	Stand By	0	0	0
	4	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	5	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	6	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	7	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
					107	76	To Deir Al Saneh	New PS	73,943	37	23729
					611	19	To Qumaym and Al Taybeh	New PS	422,236	54	34394
					757	48	To Kufur Alma	New PS	523,130	167	106243
Total required flow from PS3 to Zubdat equal 1234m^3/h											
Qumaym PS					189	151	To Jamha	New PS	130,610	132	83817
Jenin PS					123	146	To Ezimal	New PS	85,000	83	52653
Ezimal PS					8	90	To Kufur Kifia	New PS	5,528	3	2116
Kufur Alma PS					535	182.31	To Al Ashrafiyya	New PS	369,715	450	285662
New Judayta Booster					158	169.86	To Dair Smadiyeh	New PS	109,187	124	78602

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Zuqaq PS3					158	170.38	To Dair Smadiyeh	New PS	109,187	124	78843
Kofranjeh Down Booster					99	83	To Kofranjeh Up	New PS	68,415	38	23938
Zubdat	5	300	190	To Houfa				Not to be used	0	0	0
	2	500	200	To Houfa				Not to be used	0	0	0
	3	500	200	To Houfa				Not to be used	0	0	0
	4	300	250	To Bani Kinana				Not to be used	0	0	0
	1	300	250	To Bani Kinana				Not to be used	0	0	0
					105	111	To Beit Yafa	New PS	72,561	54	34240
Hofa	1	380	265	To Samad	380	265	To Samad	Stand by	0	0	0
	2	300	250	To Samad	300	250	To Samad	Use Existing	0	320	203232
	3	200	250	To Samad	200	250	To Samad	Use Existing	0	225	142898
					1047	226	To Samad	New PS	723,537	1091	693016
					363	68	To Al Hoson	New PS	250,854	114	72624
					68	115	To Juhfiyya	New PS	46,992	36	22951
Total required flow from Houfa to Samad equal 1547m^3/h											

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Samad	3	300	250	To Ras Muneef	300	250	To Ras Muneef	Use Existing	0	420	266742
	4	200	250	To Ras Muneef	200	250	To Ras Muneef	Use Existing	0	230	146073
	1	100	200	To Al Mazar	100	200	To Ras Muneef	Stand by	0	0	0
	2	150	250	To Al Mazar	150	250	To Ras Muneef	Stand by	0	0	0
					400	214	To Ras Muneef	New PS	276,423	395	250704
					495	104	To Aseem	New PS	342,073	237	150586
					8	44	Deir Al Birak	New PS	5,528	2	1036
Total required flow from Samad to Ras Muneef equal 900m^3/h											
WehdehPS0					4110	240	To Wehdeh PS1	New PS	2,840,244	4549	2888957
Wehdeh PS1					4110	191	To Wehdeh PS2	New PS	2,840,244	3621	2299609
Wehdeh PS2					3254	183.54	To Zubdat	New PS	2,248,699	2754	1749187
					856	125.66	To Sama Arrousan	New PS	591,545	496	315035
Sama Arrousan PS					39	40.5	To Safouk	New PS	26,951	7	4626
Tubneh Booster	1	50	300	To Tubneh				Not to be used	0		0
					62	219	To Tubneh	New Pumps	42,846	63	39767

Table I-1b: Cost Estimates for Alternative 1 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Supplementary Sal Reservoir Pump	1				196	25	To Sal WT	New Pump	135,447	23	14351
								Total Cost, $	**16,569,472**	**29360**	**18,646,771**

Table I-1c: Cost Estimates for Alternative 1 - Pipelines

DIAMETER	Actual Status		Total Pipe Length	Unit Cost, $/m	Total Cost,$
	Existing	New			
100	10,406	44,091	54,497	61.0	2,689,551
150	56,793	56,657	113,450	76.0	4,305,932
200	18,112	103,640	121,752	94.0	9,742,160
250	0	45,378	45,378	113.0	5,127,714
300	11,815	60,215	72,030	134.0	8,068,810
350	0	2,893	2,893	157.0	454,201
400	29,337	94,951	124,288	182.0	17,281,082
500	41,437	45,729	87,166	238.0	10,883,502
600	108,062	41,229	149,291	301.0	12,409,929
700	0	48,661	48,661	372.0	18,101,892
800	23,001	0	23,001	450.0	0
900	0	6,931	6,931	537.0	3,721,947
1000	0	18,639	18,639	617.0	11,500,263
1100	0	25,236	25,236	706.0	17,816,616
Total	**298,963**	**594,250**	**893,213**		**122,103,599**

Table I-2a: Cost Estimates for Alternative 2 - Reservoirs

WLRP ID	Distribution Zone Reservoir	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Reservoir Capacity m^3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
WA-PS3	**Wadi Al Arab PS3**				**3542**	**2476**	**6018**	**Exist 1700**		
								4,500	**766,656**	
DS02IR-1	Deir Al Saneh Reservoir	WA-PS3	643	1071	178		1892	2,000	461,835	89.3
DS01IR-1	**Qumaym Reservoir**	**WA-PS3**	**1784**	**2973**	**810**	**630**	**6196**	**6,000**	**917,672**	**247.7**
DS03IR-1	Al Taybeh Reservoir	WA-PS3	748	1247	208		2204	2,500	530,952	103.9
DS04IR-1	Mindah Reservoir	WA-PS3	688	1146	38		1872	2,000	461,835	95.5
DS05AK-11	Jenin Reservoir		315	524	87		926	1,000	299,463	43.7
DS10AK-1	Tubneh Reservoir		373	621	103		1097	1,000	299,463	51.8
DS06AK-1	Ezimal Reservoir	WA-PS3	688	1146	205		2039	2,000	461,835	95.5
DS08AK-1	Dair Abi Said Reservoir		1149	1915	320		3384	4,000	712,246	159.6
DS09AK-1	Kufur Alma Reservoir	TF-PS2	708	1180	197		2085	2,000	461,835	98.4
DS11AK-1	Al Ashrafiyya High Reservoir	TF-PS2	877	1461	243		2582	3,000	595,036	121.8
DS12AK-1	Al Ashrafiyya low Reservoir	TF-PS2	347	578	97		1021	1,000	299,463	48.1
DS13AK-1	Kufur Awan Reservoir	TF-PS2	1037	1728	288		3053	3,000	595,036	144.0
DS07AK-1	Kufur Kifia WT	WA-PS3	47	79	13		139	500	518,258	6.6
ZE01IR-1	**Zebda**		**19134**	**31890**	**4850**	**2796**	**71808**	**Existing 110000**		**2657.5**
ZE02IR-1	Kufur Youba	WA-PS3	508	846	142		1495	1,500	385,833	70.5
ZE03IR-1	Jamha	DS01IR-1	91	151	25		267	350	155,377	12.6
ZE04IR-1	Soum	DS01IR-1	615	1026	290		1931	2,000	461,835	85.5
ZE05IR-1	Jijeen	DS01IR-1	565	942	38		1546	1,500	385,833	78.5
ZE06IR-1	Sal	WE-PS2	1978	3297	550		5825	6,000	917,672	274.8
ZE06IR-2	Sal WT	WE-PS2	1177	1962	327		3465	500	518,258	163.5
	Sal WT Supplementary Reservoir							3,000	595,036	
ZE07IR-1	Al Mughayyir	WE-PS2	498	831	138		1467	1,500	385,833	69.2
ZE08IR-1	Foua'ra	WE-PS2	532	887	148		1568	1,500	385,833	73.9
ZE09IR-1	Beit Ras	WE-PS2	1573	2622	437		4631	5,000	818,840	218.5
ZE10BK-1	**Sama Arrousan**	**WE-PS2**	**2533**	**4221**	**1427**	**1447**	**9627**	**10,000**	**1,262,824**	**351.8**
ZE11BK-1	Safouk WT	ZE10BK-1	233	389	65		687	500	518,258	32.4
ZE12BK-1	Durama	ZE10BK-1	599	998			1596	1,500	385,833	83.1
ZE13BK-1	Hartha	ZE10BK-1	1005	1675			2680	3,000	595,036	139.6

Table I-2a: Cost Estimates for Alternative 2 - Reservoirs - Continued

WLRP ID	Distribution Zone Reservoir	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Reservoir Capacity m^3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE14BK-1	Saham	ZE10BK-1	761	1269			2030	2,000	461,835	105.8
ZE15O-1	Edoun	ZE16IR-1	1747	2912			4658	5,000	818,840	242.6
ZE16IR-1	**Hofa**		**1573**	**2622**	**5000**	**2850**	**12044**	**Existing 12000**		**218.5**
ZE17O-1	Sareeh	ZE16IR-1	128	213			341	350	155,377	17.8
ZE18IR-1	Ham	ZE16IR-1	167	278			445	500	194,178	23.2
ZE19IR-1	Beit Yafa	ZE01IR-1	632		175		807	1,000	299,463	87.8
ZE20IR-1	Deir Yousef		285	476	80		841	1,000	299,463	39.6
ZE21IR-1	Juhfiyya	ZE16IR-1	181	302	50		532	500	194,178	25.1
ZE22IR-1	Habaka	ZE16IR-1	226	377	63		667	750	250,182	31.4
ZE23O-1	Al Hoson	ZE16IR-1	2179	3632	605		6416	7,000	1,010,483	302.6
ZE24IR-1	**Samad**	**ZE16IR-1**	**138**	**230**	**2537**	**443**	**3348**	**Existing 550** **3,000**	**595,036**	**19.2**
ZE25O-1	Shatana	ZE24IR-1	10	16			26	100	71,014	1.3
ZE28O-1	Kitim		364	607	102		1072	1,000	299,463	50.5
ZE29IR-1	Dair Al Birak	ZE24IR-1	47	78	13		138	150	91,496	6.5
ZE30IR-1	Almazar	ZE24IR-1	717	1195			1911	2,000	461,835	99.5
ZE31IR-1	Ibya		318	530	88		936	1,000	299,463	44.1
ZE32IR-1	E'nbeh		435	725	117		1276	1,500	385,833	60.4
ZE33AJ-1	**A'seem**	**ZE24IR-1**	**27**	**45**	**253**	**493**	**819**	**1,000**	**299,463**	**3.8**
ZE34AJ-1	Sana'ar	ZE33AJ-1	112	187			298	350	155,377	15.5
ZE35IR-1	Erhaba	ZE33AJ-1	689	1149			1838	2,000	461,835	95.7
ZE36AJ-1	**Ras Muneef**	**ZE24IR-1**	**1081**	**1801**	**2030**	**2896**	**7808**	**Existing 6300** **1,500**	**385,833**	**150.1**
ZE37AJ-1	Rasoun	ZE33AJ-1	121	201	10		332	350	155,377	16.8
ZE38AJ-1	Arjan		341	568	95		1004	1,000	299,463	47.3
ZE39AJ-1	Ba'oon		330	550	92		971	1,000	299,463	45.8
ZE40AJ-1	**Sakhra**	**ZE36AJ-1**	**481**	**802**		**563**	**1846**	**2,000**	**461,835**	**66.8**
ZE41JE-1	Kufr Khal	ZE40AJ-1	554	923			1477	1,500	385,833	76.9
ZE42JE-1	Souf Down	ZE36AJ-1	726	1211			1937	2,000	461,835	100.9
ZE43JE-1	Souf Up	ZE36AJ-1	429	715	67		1210	1,500	385,833	59.5

Table I-2a: Cost Estimates for Alternative 2 - Reservoirs - Continued

WLRP ID	Distribution Zone Reservoir	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Reservoir Capacity m^3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE45JE-1	Raymun	ZE36AJ-1	429	716			1145	1,000	299,463	59.6
ZE50JE-1	Hooneh	TF-PS2	102	171			273	350	155,377	14.2
ZE51JE-1	Sakeb	ZE36AJ-1	725	1209			1934	2,000	461,835	100.7
ZE52JE-1	Al Husayniyyat	ZE36AJ-1	41	68			108	100	71,014	5.6
ZE53JE-1	Jabal Akhdar	TF-PS2	50	83	42		174	150	91,496	6.9
ZE54AJ-1	Mazraat Eshkarah	TF-PS2	129	215	37		381	350	155,377	17.9
ZE55AJ-1	Ajloun	ZE36AJ-1	571	952			1523	1,500	385,833	79.3
ZE56AJ-1	Ishtafina	ZE36AJ-1	39	66			105	100	71,014	5.5
ZE57AJ-1	Dair Smadiyeh	TF-PS2	120	201	33		354	350	155,377	16.7
ZE58AJ-1	Al Hashemiah	TF-PS2	806	1344	223		2373	3,000	595,036	112.0
ZE59AJ-1	Ain Jana	ZE36AJ-1	629	1048	18		1694	2,000	461,835	87.3
ZE60AJ-1	Anjarah Down	ZE36AJ-1	729	1216			1945	2,000	461,835	101.3
ZE61AJ-1	Anjarah Up	ZE36AJ-1	717	1195			1911	2,000	461,835	99.5
ZE62AJ-1	Kofranjeh Down	TF-PS2	803	1338	223		2364	3,000	595,036	111.5
ZE63AJ-1	Kofranjeh Up	TF-PS2	592	987	165		1743	2,000	461,835	82.2
RA01RA-1	Ramtha-JUST Reservoir	ZA01MA-1	190	317	53		560	500	194,178	26.4
RA02RA-1	**Ramtha City Reservoir**	**ZE01IR-1**	**4406**		**1800**	**1153**	**7359**	**8,000**	**1,098,434**	**611.9**
RA03RA-1	Al Toura Reservoir	RA02RA-1	1027				1027	1,000	299,463	142.7
RA04RA-1	Ash Shajara Reservoir	RA02RA-1	1027				1027	1,000	299,463	142.7
RA05RA-1	Emrawa & Ath Thunayba Reservoir	RA02RA-1	790		82		872	1,000	299,463	109.7
RA06RA-1	Al Bowayda Reservoir 69	ZA01MA-1	415	692	115		1223	1,500	385,833	57.7
JE03JE-1	Qafqafa Reservoir	ZE40AJ-1	300	501			801	1,000	299,463	41.7
JE04JE-1	Thugrat Asfoor Reservoir	ZE40AJ-1	10	17			28	100	71,014	1.4
JE07JE-1	Muqbla Reservoir	ZE40AJ-1	151	252			403	500	194,178	21.0
WE-PS2	**Wehdeh PS2 Reservoir**		**0**	**0**		**3846**	**3846**	**4,000**	**712,246**	
TF-PS1	Tabaqit Fahil PS1 Reservoir		0	0			0	2,000	461,835	
TF-PS2	**Tabaqit Fahil PS2 Reservoir**		**0**	**0**		**2260**	**2260**	**2,000**	**461,835**	
UL01MA-1	**Um El Lulu Reservoir**	**ZA01MA-1**	**360**	**600**	**1247**	**557**	**2763**	**Existing 550**		**50.0**
								3,000	**595,036**	
UL03MA-1	Bani Hasan Reservoir	UL01MA-1	631	1051	175		1857	2,000	461,835	87.6

Table I-2a: Cost Estimates for Alternative 2 - Reservoirs - Continued

WLRP ID	Distribution Zone Reservoir	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Reservoir Capacity m^3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
UL02MA-1	Um Neam Reservoir	UL01MA-1	283	471	78		832	1,000	299,463	39.3
UL04MA-1	**Buwayda Reservoir**	**UL01MA-1**	**0**	**0**	**868**	**843**	**1712**	**2,000**	**461,835**	**0.0**
UL05MA-1	Buwayda WT	UL04MA-1	107	179	30		316	500	518,258	14.9
UL10MA-2	Rhab WT	UL04MA-1	128	213	35		376	500	518,258	17.8
UL10MA-1	Qadem Reservoir (Rhab Reservoir)	UL04MA-1	154	256	43		453	Existing 500		21.3
UL06MA-1	Dajaniyya Reservoir	UL04MA-1	229	381	63		673	750	250,182	31.8
UL07MA-1	HAMAMA Reservoir	UL04MA-1	95	159			254	350	155,377	13.2
UL13MA-1	Balama Reservoir	ZA05MA-1	796	1327	222		2345	3,000	595,036	110.6
UL14MA-1	Az Zannieh WT		161	268	45		475	500	518,258	22.4
UL09MA-1	Nadira Reservoir	UL08MA-1	155	258	447		859	1,000	299,463	21.5
UL12MA-1	Hameed Reservoir	ZA05MA-1	31	51	8		90	Existing 130		4.3
UL11MA-1	Mo'ammariyeh Reservoir	ZA05MA-1	204	339	57		599	750	250,182	28.3
UL08MA-1	**MIDAWAR Reservoir**	**UL04MA-1**	**111**	**185**	**30**	**893**	**1219**	**1,500**	**385,833**	**15.4**
UL15MA-1	Mazra'a Reservoir		349	581	97		1026	1,000	299,463	48.4
ZA02MA-1	Baij	ZA01MA-1	707	1179	197		2083	2,000	461,835	98.2
ZA03MA-1	Sarhan Reservoir	ZA01MA-1	747	1245	208		2201	3,000	595,036	103.8
ZA03MA-2	Jaber Reservoir	UL01MA-1	404	674	112		1189	1,500	385,833	56.1
ZA01MA-1	**Za'tary Reservoir**	**ZA01MA-1**	**472**	**786**	**7155**	**2015**	**10428**	**Existing 10,000**		**65.5**
ZA04MA-1	Hamra DZR	UL01MA-1	596	994	140		1730	2,000	461,835	82.8
ZA05MA-1	**Mafraq DZR**		**3689**	**6148**	**1902**	**1753**	**13492**	**14,000**	**1,558,378**	**512.4**
ZA07MA-1	Khalidiyya	ZA01MA-1	1340	2234	372		3946	4,000	712,246	186.1
ZA08MA-1	Thugrat AlJubb	ZA01MA-1	175	292	48		516	500	194,178	24.3
ZA06MA-1	Hayyan	ZA05MA-1	304	506	85		895	1,000	299,463	42.2
LM01MA-1	As Suwaylima	UL01MA-1	133	222	47		402	500	194,178	18.5
JE01JE-1	Musherfa Reservoir	UL04MA-1	187	312	52		551	500	194,178	26.0
JE02JE-1	Balila Reservoir	UL04MA-1	362	604	100		1067	1,000	299,463	50.3
JE06JE-1	Jerash Up Reservoir	ZA05MA-1	756	1261	210		2227	3,000	595,036	105.1
JE05JE-1	Majar Reservoir	UL08MA-1	232	386			618	750	250,182	32.2
JE09JE-1	Jerash Down Reservoir	ZA05MA-1	1328	2213	368		3909	4,000	712,246	184.4

Table I-2a: Cost Estimates for Alternative 2 - Reservoirs - Continued

WLRP ID	Distribution Zone Reservoir	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Reservoir Capacity m^3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
JE08JE-1	Souf Ref. Camp Reservoir	ZA05MA-1	836	1393	232		2460	Existing 750 1,500	 385,833	116.1
ZE44JE-1	Dair Al liyyat	UL08MA-1	439	732			1171	1,000	299,463	61.0
ZE46JE-1	ketta	UL08MA-1	726	1210			1935	2,000	461,835	100.8
ZE47JE-1	Nahla	UL08MA-1	53	88			141	150	91,496	7.3
ZE48JE-1	Burma down	ZA05MA-1	419	699	117		1235	1,500	385,833	58.3
ZE49JE-1	Burma UP	ZA05MA-1	184	307	52		542	500	194,178	25.5
ZE26O-1	Nuaimeh down		392	653	112		1156	1,000	299,463	54.4
ZE27O-1	Nuaimeh up	UL04MA-1	421	702	117		1240	1,500	385,833	58.5
	Total Cost, $								**49,482,268**	

* V2 of the concerned reservoirs has been considered in the existing Zabda reservoir

** The reservoir taking care of the V4

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Um El-Lulu	1	300	220	To Bwaydah P.S					0	0	0
	2	380	265	To Bwaydah P.S					0	0	0
	3	300	250						0	0	0
	4	300	350						0	0	0
					626	155	To Bwaydah P.S	New	432,602	447	284,180
					47	83	To Um Naam	New	32,480	18	11,425
Bwaydah P.S	1	50	250					Not to be used	0	0	0
	2	60	250					Not to be used	0	0	0
	3	75	200					Not to be used	0	0	0
	4	100	200					Not to be used	0	0	0
					199	79	To Dajania	New	137,520	72	46,043
					38	24	To Rhab	New	26,260	4	2,671
Zatary P.S	1	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Use Existing	0	500	317,550
	2	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Use Existing	0	500	317,550
	3	380	265	To Um El-Lulu P.S	380	265	To Um El-Lulu P.S	Use Existing	0	440	279,444
	4	380	265	To Um El-Lulu P.S	380	265	To Um El-Lulu P.S	Stand by	0	0	0

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Zatary P.S	5	500	250	To Um El-Lulu P.S	500	250	To Um El-Lulu P.S	Stand by	0	0	0
	6	500	100					Not to be used	0	0	0
	7	500	117					Not to be used	0	0	0
	8	128	100					Not to be used	0	0	0
	9	500	100					Not to be used	0	0	0
	10	500	100					Not to be used	0	0	0
	11	128	100					Not to be used	0	0	0
					2469	233	To Um El-Lulu P.S	New	1,706,220	2,653	1,684,864
					252	161	To Thughrat al Jubb	New	174,146	187	118,827
					84	32	To Sarhan	New	58,049	12	7,873
					29	181	To Baej	New	20,041	24	15,373
Mafraq P.S					526	205	Mafraq to Hayan and Jerash	New P.S	363,496	497	315,811
Midwar P.S					268	119	To Nadira	New P.S	185,203	147	93,405
Wadi Al Arab PS0	1	625	320	To PS1				Not to be used	0	0	0
	2	625	320	To PS1				Not to be used	0	0	0
	3	625	320	To PS1				Not to be used	0	0	0
					600	231	KAC Water to PS1	New Pumps	414,634	639	405,930

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS1	1	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355,656
	2	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355,656
	3	576	235	To PS2	576	235	To Wadi Al Arab PS2	Stand By	0	0	0
	4	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317,550
	5	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317,550
	6	567	220	To PS2	567	220	To Wadi Al Arab PS2	Stand By	0	0	0
	7	567	220	To PS2	567	220	To Wadi Al Arab PS2	Stand By	0	0	0
Total required flow from PS1 to PS2 equal 2125m^3/h											
Wadi Al Arab PS2	1	666	250	To PS3	666	250	To Wadi Al Arab PS3	Use Existing	0	675	428,693
	2	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	3	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	4	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
	5	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS2	6	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
	7	567	216	To PS3	567	216	To Wadi Al Arab PS3	Stand By	0	0	0
Total required flow from PS2 to PS3 equal 2125m^3/h											
Wadi Al Arab PS3	1	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428,693
	2	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428,693
	3	666	250	To Zubdat	666	250	To Zubdat	Stand By	0	0	0
	4	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	5	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	6	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	7	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
					107	80	To Deir Al Saneh	New PS	73,943	39	25,070
					611	23	To Qumaym and Al Taybeh	New PS	422,236	65	41,158
					123	200	To Ezimal	New PS	85,000	113	72,048
Total required flow from PS3 to Zubdat equal 1193m^3/h											
Qumaym PS					189	152	To Jamha	New PS	130,610	132	84,138
Ezimal PS					8	90	To Kufur Kifia	New PS	5,528	3	2,116
New Judayta Booster					183	166	To Dair Smadiyeh	New PS	126,463	140	88,730

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Zuqaq PS3					183	166	To Dair Smadiyeh	New PS	126,463	140	89,030
Kofranjeh Down Booster					124	90	To Kofranjeh Up & Eshkarah	New PS	85,691	51	32,685
Eshkarah Booster					25	120	To Al Jabal Al Akhdar	New PS	17,276	14	8,770
Zubdat	1	300	190	To Hofa				Not to be used	0	0	0
	2	500	200	To Hofa				Not to be used	0	0	0
	3	500	200	To Hofa				Not to be used	0	0	0
	4	300	250	To Bani Kinana				Not to be used	0	0	0
	5	300	250	To Bani Kinana				Not to be used	0	0	0
					105	107	To Beit Yafa	New PS	72,561	52	32,905
Hofa	1	380	265	To Samad	380	265	Stand by	Use Existing	0	0	0
	2	300	250	To Samad	300	250	To Samad	Use Existing	0	320	203,232
	3	200	250	To Samad	200	250	To Samad	Use Existing	0	225	142,898
					1022	225	To Samad	New PS	706,260	1,060	673,475
					424	133	To Al Hoson	New PS	293,008	260	165,160
					68	115	To Juhfiyya	New PS	46,992	36	22,951
Total required flow from Hofa to Samad equal 1522m3/h											

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Samad	3	300	250	To Ras Muneef	300	250	To Ras Muneef	Use Existing	0	420	266,742
	4	200	250	To Ras Muneef	200	250	To Ras Muneef	Use Existing	0	230	146,073
	1	100	200	To Al Mazar	100	200	To Ras Muneef	Stand by	0		0
	2	150	250	To Al Mazar	150	250	To Ras Muneef	Stand by	0		0
					718	223	To Ras Muneef	New PS	496,179	738	468,940
					152	92	To Aseem	New PS	105,041	64	40,956
					8	44	Deir Al Birak	New PS	5,528	2	1,036
Total required flow from Samad to Ras Muneef equal 1218m^3/h											
WehdehPS0					4110	240	To Wehdeh PS1	New PS	2,840,244	4,549	2,888,957
Wehdeh PS1					4110	191	To Wehdeh PS2	New PS	2,840,244	3,621	2,299,609
Wehdeh PS2					3254	184	To Zubdat	New PS	2,248,699	2,754	1,749,187
					856	126	To Sama Arrousan	New PS	591,545	496	315,035
Sama Arrousan PS					39	41	To Safouk	New PS	26,951	7	4,626
Tubneh Booster	1	50	300	To Tubneh				Not to be used	0	0	0
					62	219	To Tubneh	New Pumps	42,846	63	39,767

Table I-2b: Cost Estimates for Alternative 2 - Pump Stations and Annual Power Costs - Continued

Required P.S	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Tabaqit Fahil PS0					675	236	To Tabaqit Fahil PS1	New PS	466,463	735	466,556
Tabaqit Fahil PS1					675	236	To Tabaqit Fahil PS2	New PS	466,463	735	466,556
Tabaqit Fahil PS2					675	236	To Al Koura	New PS	466,463	735	466,556
Supplementary Sal Reservoir Pump	1				196	25	To Sal WT	New Pump	135,447	23	14,351
								Total Cost, $	**16,474,797**		**18,805,399**

Table I-2c: Cost Estimates for Alternative 2 - Pipelines

DIAMETER	Actual Status		Total Pipe Length	Unit Cost, $/m	Total Cost,$
	Existing	New			
100	0	45,883	45,883	61.0	2,798,863
150	43,191	62,580	105,771	76.0	4,756,080
200	25,886	96,470	122,356	94.0	9,068,180
250	0	48,493	48,493	113.0	5,479,709
300	16,528	90,523	107,051	134.0	12,130,082
350	0	5,035	5,035	157.0	790,495
400	42,823	67,448	110,271	182.0	12,275,536
500	33,870	55,479	89,349	238.0	13,204,002
600	106,030	34,032	140,062	301.0	10,243,632
700	0	48,627	48,627	372.0	18,089,244
800	23,001	0	23,001	450.0	0
900	0	6,931	6,931	537.0	3,721,947
1000	0	18,240	18,240	617.0	11,254,080
1100	0	25,635	25,635	706.0	18,098,310
Total	**291,329**	**605,376**	**896,705**		**121,910,160**

Table I-3a: Cost Estimates for Alternative 3 - Reservoirs

WLRP ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
WA-PS3	**Wadi Al Arab PS3**				**4667**	**1347**	**6013**	**Exist 1700**		
								4,500	**766,656**	
DS02IR-1	**Deir Al Saneh Reservoir**	**WA-PS3**	**643**	**1071**	**1537**	**1943**	**5194**	**5000**	**818,840**	**89.3**
DS01IR-1	Qumaym Reservoir	WA-PS3	1784	2973	495		5252	6000	917,672	247.7
DS03IR-1	Al Taybeh Reservoir	WA-PS3	748	1247			1995	2000	461,835	103.9
DS04IR-1	Mindah Reservoir	WA-PS3	688	1146	40		1874	2000	461,835	95.5
DS05AK-11	Jenin Reservoir	DS02IR-1	315	524			839	1000	299,463	43.7
DS10AK-1	Tubneh Reservoir	DS02IR-1	373	621	103		1097	1000	299,463	51.8
DS06AK-1	Ezimal Reservoir	DS02IR-1	688	1146	205		2039	2000	461,835	95.5
DS08AK-1	**Dair Abi Said Reservoir**	**DS02IR-1**	**1149**	**1915**	**543**	**1856**	**5464**	**6000**	**917,672**	**159.6**
DS09AK-1	Kufur Alma Reservoir	DS08AK-1	708	1180	958		2847	3000	595,036	98.4
DS11AK-1	Al Ashrafiyya High Reservoir	DS08AK-1	877	1461	628		2967	3000	595,036	121.8
DS12AK-1	Al Ashrafiyya low Reservoir	DS08AK-1	347	578			924	1000	299,463	48.1
DS13AK-1	Kufur Awan Reservoir	DS08AK-1	1037	1728			2765	3000	595,036	144.0
DS07AK-1	Kufur Kifia WT	DS02IR-1	47	79	13		139	500	518,258	6.6
ZE01IR-1	**Zebda**	**WE-PS2**	**19134**	**31890**	**9485**	**44698**	**105208**	**Existing 110000**		**2657.5**
ZE02IR-1	Kufur Youba	ZE01IR-1	508	*	142		649	750	250,182	70.5
ZE03IR-1	Jamha	ZE01IR-1	91	*			91	100	71,014	12.6
ZE04IR-1	Soum	ZE01IR-1	615	*			615	750	250,182	85.5
ZE05IR-1	Jijeen	ZE01IR-1	565	*	38		604	750	250,182	78.5
ZE06IR-1	Sal	ZE01IR-1	1978	*	332		2310	3000	595,036	274.8
ZE06IR-2	Sal WT	ZE01IR-1	1177	*	327		1504	500	518,258	163.5
	Sal WT Supplementary Reservoir							1000	299,463	
ZE07IR-1	Al Mughayyir	ZE01IR-1	498	*	48		547	500	194,178	69.2
ZE08IR-1	Foua'ra	ZE01IR-1	532	*			532	500	194,178	73.9
ZE09IR-1	Beit Ras	ZE01IR-1	1573	*			1573	1,500	385,833	218.5
ZE10BK-1	Sama Arrousan	ZE01IR-1	2533	*			2533	3,000	595,036	351.8
ZE11BK-1	Safouk WT	ZE01IR-1	233	*	65		298	500	518,258	32.4
ZE12BK-1	Durama	ZE01IR-1	599	*			599	750	250,182	83.1
ZE13BK-1	Hartha	ZE01IR-1	1005	*			1005	1,000	299,463	139.6
ZE14BK-1	Saham	ZE01IR-1	761	*			761	750	250,182	105.8
ZE15O-1	Edoun	ZE01IR-1	1747	*	485		2232	3,000	595,036	242.6

Table I-3a: Cost Estimates for Alternative 3 - Reservoirs - Continued

WLRP ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE16IR-1	**Hofa**	**ZE01IR-1**	**1573**	**2622**	**4895**	**1583**	**10673**	**Existing 12000**		**218.5**
ZE17O-1	Sareeh	ZE16IR-1	128	*			128	150	91,496	17.8
ZE18IR-1	Ham		167	278	47		491	500	194,178	23.2
ZE19IR-1	Beit Yafa	ZE01IR-1	632	*	47		679	750	250,182	87.8
ZE20IR-1	Deir Yousef		285	476	208		969	1000	299,463	39.6
ZE21IR-1	Juhfiyya	ZE16IR-1	181	*	50		231	250	125,909	25.1
ZE22IR-1	Habaka	ZE16IR-1	226	*	63		290	350	155,377	31.4
ZE23O-1	Al Hoson	ZE16IR-1	2179	*	605		2784	3000	595,036	302.6
ZE24IR-1	**Samad**	**ZE16IR-1**	**138**	**230**	**3707**	**1736**	**5811**	**Existing 550** **6000**	**917,672**	**19.2**
ZE25O-1	Shatana	ZE24IR-1	10	*	3		13	100	71,014	1.3
ZE26O-1	Nuaimeh down	ZE24IR-1	392	*	112		503	500	194,178	54.4
ZE27O-1	Nuaimeh up	ZE24IR-1	421	*	117		538	500	194,178	58.5
ZE28O-1	Kitim	ZE24IR-1	364	*			364	500	194,178	50.5
ZE29IR-1	Dair Al Birak	ZE24IR-1	47	*	13		60	100	71,014	6.5
ZE30IR-1	Almazar	ZE24IR-1	717	*			717	2,000	461,835	99.5
ZE31IR-1	Ibya	ZE24IR-1	318	*			318	1000	299,463	44.1
ZE32IR-1	E'nbeh	ZE24IR-1	435	*			435	1500	385,833	60.4
ZE33AJ-1	A'seem	ZE24IR-1	27	*	7		34	100	71,014	3.8
ZE34AJ-1	Sana'ar	ZE24IR-1	112	*	32		144	150	91,496	15.5
ZE35IR-1	Erhaba	ZE24IR-1	689	*	192		881	1000	299,463	95.7
ZE36AJ-1	**Ras Muneef**		**1081**	**1801**	**2800**	**5000**	**10681**	**Existing 6300** **3000**	**595,036**	**150.1**
ZE37AJ-1	Rasoun	ZE36AJ-1	121	201			322	350	155,377	16.8
ZE38AJ-1	Arjan		341	568	95		1004	1000	299,463	47.3
ZE39AJ-1	Ba'oon		330	550	92		971	1000	299,463	45.8
ZE40AJ-1	Sakhra	ZE36AJ-1	481	802			1282	1500	385,833	66.8
ZE41JE-1	Kufr Khal	ZE36AJ-1	554	923			1477	1500	385,833	76.9
ZE42JE-1	Souf Down	ZE36AJ-1	726	1211			1937	2,000	461,835	100.9
ZE43JE-1	Souf Up	ZE36AJ-1	429	715	67		1210	1500	385,833	59.5
ZE44JE-1	Dair Al liyyat	ZE36AJ-1	439	732			1171	1500	385,833	61.0
ZE45JE-1	Raymun	ZE36AJ-1	429	716			1145	1500	385,833	59.6

Table I-3a: Cost Estimates for Alternative 3 - Reservoirs - Continued

WLRP ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
ZE46JE-1	Al ketta	ZE36AJ-1	726	1210			1935	2,000	461,835	100.8
ZE47JE-1	Nahla	ZE36AJ-1	53	88			141	150	91,496	7.3
ZE48JE-1	Burma down	ZE36AJ-1	419	699			1118	1500	385,833	58.3
ZE49JE-1	Burma UP	ZE36AJ-1	184	307			490	500	194,178	25.5
ZE50JE-1	Hooneh	ZE36AJ-1	102	171			273	350	155,377	14.2
ZE51JE-1	Sakeb	ZE36AJ-1	725	1209			1934	2,000	461,835	100.7
ZE52JE-1	Al Husayniyyat	ZE36AJ-1	41	68			108	Existing 675		5.6
ZE53JE-1	Jabal Akhdar	ZE36AJ-1	50	83			132	150	91,496	6.9
ZE54AJ-1	Mazraat Eshkarah		129	215	37		381	350	155,377	17.9
ZE55AJ-1	Ajloun	ZE36AJ-1	571	952			1523	1,500	385,833	79.3
ZE56AJ-1	Ishtafina	ZE36AJ-1	39	66			105	Existing 100		5.5
ZE57AJ-1	Dair Smadiyeh	ZE36AJ-1	120	201			321	350	155,377	16.7
ZE58AJ-1	Al Hashemiah		806	1344	223		2373	3,000	595,036	112.0
ZE59AJ-1	Ain Jana	ZE36AJ-1	629	1048	18		1694	2,000	461,835	87.3
ZE60AJ-1	Anjarah Down	ZE36AJ-1	729	1216			1945	2,000	461,835	101.3
ZE61AJ-1	Anjarah Up	ZE36AJ-1	717	1195			1911	2,000	461,835	99.5
ZE62AJ-1	Kofranjeh Down	ZE36AJ-1	803	1338	95		2236	3,000	595,036	111.5
ZE63AJ-1	Kofranjeh Up	ZE36AJ-1	592	987			1578	1,500	385,833	82.2
WE-PS2	**Wehdeh PS2 Reservoir**							**4000**	**712,246**	
RA01RA-1	Ramtha-JUST Reservoir	ZA01MA-1	190	317	1253	2400	4160	4000	712,246	26.4
RA02RA-1	Ramtha City Reservoir		4406	7343	600		12348	13000	1,487,844	611.9
RA03RA-1	Al Toura Reservoir		1027	1712	132		2871	3000	595,036	142.7
RA04RA-1	Ash Shajara Reservoir		1027	1712	82		2821	3000	595,036	142.7
RA05RA-1	Emrawa & Ath Thunayba Reservoir		790	1317			2107	2000	461,835	109.7
RA06RA-1	Al Bowayda Reservoir	ZA01MA-1	415	692	115		1223	1500	385,833	57.7
JE03JE-1	**Qafqafa Reservoir**	**UL01MA-1**	**299**	**498**	**737**	**1307**	**2840**	**3000**	**595,036**	**41.5**
JE01JE-1	Musherfa Reservoir	UL01MA-1	187	312	52		551	750	250,182	26.0
JE02JE-1	Balila Reservoir	UL01MA-1	362	604	100		1067	1000	299,463	50.3
JE04JE-1	Thugrat Asfoor	JE03JE-1	10	17	653		681	750	250,182	1.4
JE07JE-1	Muqbla Reservoir	JE03JE-1	151	252			403	500	194,178	21.0
JE06JE-1	Jerash Up Reservoir	JE03JE-1	756	1261			2017	2000	461,835	105.1
JE05JE-1	Majar Reservoir	JE03JE-1	232	386			618	750	250,182	32.2

Table I-3a: Cost Estimates for Alternative 3 - Reservoirs - Continued

WLRP ID	Reservoir Name	V4 Reservoir ID **	Vol 1	Vol 2	Vol 3	Vol 4	Required Vol, m3	Recommended m3	Estimate Cost,$	Demand 2030 (m3/h)
JE09JE-1	Jerash Down Reservoir	JE03JE-1	1328	2213	267		3807	4000	712,246	184.4
JE08JE-1	Souf Ref. Camp Reservoir	JE03JE-1	836	1393			2228	Existing 750 1500	 385,833	116.1
UL01MA-1	**Um El Lulu Reservoir**	**ZA01MA-1**	**360**	**600**	**1520**	**977**	**3456**	**Existing 550** **3,000**	 **595,036**	**50.0**
UL03MA-1	Bani Hasan Reservoir	UL01MA-1	631	1051	175		1857	2,000	461,835	87.6
UL02MA-1	Um Neam Reservoir	UL01MA-1	283	471	78		832	1,000	299,463	39.3
UL04MA-1	**Buwayda Reservoir**	**UL01MA-1**			**277**	**553**	**830**	**1,000**	**299,463**	
UL05MA-1	Buwayda WT	UL04MA-1	107	179	30		316	500	518,258	14.9
UL10MA-2	Rhab WT	UL04MA-1	128	213	35		376	500	518,258	17.8
UL10MA-1	Qadem Reservoir (Rhab Reservoir)	UL04MA-1	154	256	45		455	Existing 550		21.3
UL06MA-1	Dajaniyya Reservoir	UL04MA-1	229	381	63		673	750	250,182	31.8
UL07MA-1	HAMAMA Reservoir	UL04MA-1	95	159			254	350	155,377	13.2
UL13MA-1	Balama Reservoir	UL04MA-1	796	1327	207		2330	3,000	595,036	110.6
UL14MA-1	Az Zannieh WT	UL04MA-1	161	268	45		475	500	518,258	22.4
UL09MA-1	Nadira Reservoir	UL04MA-1	155	258	43		456	500	194,178	21.5
UL12MA-1	Hameed Reservoir	UL04MA-1	31	51			82	Existing 130		4.3
UL11MA-1	Mo'ammariyeh Reservoir	UL04MA-1	204	339			543	500	194,178	28.3
UL08MA-1	MIDAWAR Reservoir	UL04MA-1	111	185	30		325	350	155,377	15.4
UL15MA-1	Mazra'a Reservoir	UL04MA-1	349	581	97		1026	1,000	299,463	48.4
ZA02MA-1	Baij Reservoir	ZA01MA-1	707	1179	197		2083	2000	461,835	98.2
ZA03MA-1	Sarhan Reservoir	ZA01MA-1	747	1245	227		2219	2000	461,835	103.8
ZA03MA-2	Jabir Reservoir	ZA01MA-1	404	674	93		1171	1000	299,463	56.1
ZA01MA-1	**Zatary Reservoir**	**ZA01MA-1**	**472**	**786**	**8427**	**2795**	**12480**	**Existing 10,000** **2500**	 **530,952**	**65.5**
ZA04MA-1	Hamra DZR	ZA01MA-1	596	994	165		1755	2000	461,835	82.8
ZA05MA-1	Mafraq DZR		3689	6148	1025		10863	11,000	1,340,335	512.4
ZA07MA-1	**Khaldiyeh**	**ZA01MA-1**	**1340**	**2234**	**420**	**97**	**4091**	**4,000**	**712,246**	**186.1**
ZA08MA-1	Thugrat AlJubb	ZA07MA-1	175	292	48		516	500	194,178	24.3
ZA06MA-1	Hayyan	ZA01MA-1	304	506	85		895	1,000	299,463	42.2
LM01MA-1	As Suwaylima	ZA01MA-1	133	222	47		402	500	194,178	18.5
	Total Cost,$								**46,088,016**	

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Um El-Lulu	1	300	220					Not to be used	0		
	2	380	265					Not to be used	0		
	3	300	250					Not to be used	0		
	4	300	350	To Qafqafa	300	350	To Qafqafa	Use Existing	0	500	317,550
					385	289	To Qafqafa	New	266,057	512	325,308
					166	115	To Um Naam	New	114,715	88	55,911
Bwaydah P.S	1	50	250					Not to be used	0		0
	2	60	250					Not to be used	0		0
	3	75	200					Not to be used	0		0
	4	100	200					Not to be used	0		0
					38	32	To Dajania	New	26,260	6	3,561
					18	10	To Rhab Tower	New	12,439	1	527
Zatary P.S	1	500	250	To Um El-Lulu P.	500	250	To Um El-Lulu P.S	Use Existing	0	500	317,550
	2	500	250	To Um El-Lulu P.	500	250	To Um El-Lulu P.S	Use Existing	0	500	317,550
	3	380	265	To Um El-Lulu P.	380	265	To Um El-Lulu P.S	Use Existing	0	440	279,444
	4	380	265	To Um El-Lulu P.	380	265	To Um El-Lulu P.S	Stand By	0	0	0
	5	500	250	To Um El-Lulu P.	500	250	To Um El-Lulu P.S	Stand By	0	0	0
	6	500	100					Not to be used	0		0
	7	500	117					Not to be used	0		0

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Zatary P.S	8	128	100					Not to be used	0		0
	9	500	100					Not to be used	0		0
	10	500	100					Not to be used	0		0
	11	128	100					Not to be used	0		0
					3221	214	To Um El-Lulu P.S	New	2,225,894	3,179	2,018,796
					29	156	To Baej	New	20,041	21	13,250
					95	32	To Sarhan	New	65,650	14	8,904
Khaldiyeh	1	150	300					Not to be used	0		0
	2	200	250					Not to be used	0		0
	3	200	250					Not to be used	0		0
	4	50	300					Not to be used	0		0
	5	200	100	To Khaldiyeh and Thughret Al-Jubb	200	100	To Khaldiyeh and Thughret Al-Jubb	Use Existing	0	110	69,861
					54	102	To Khaldiyeh and Thughret Al-Jubb	New	37,317	25	16,132
Khaldiyeh New P.S					31	101	To Thughret Al-Jubb	New P.S	21,423	14	9,170
											0
Qadam P.S					21	32	To Rhab WT	New P.S	14,512	3	1,968

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Midwar P.S					26	154	To Nadira	New P.S	17,967	18	11,727
Qafqafa P.S					392	48	To Thughret Asfour	New P.S	270,894	87	55,108
Wadi Al Arab PS0	1	625	320	To PS1				Not to be used	0		0
	2	625	320	To PS1				Not to be used	0		0
	3	625	320	To PS1				Not to be used	0		0
					675	136	Booster TF to PS1	New Pumps	466,463	423	268,863
					600	257	KAC Water to PS1	New Pumps	414,634	711	451,619

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS1	1	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355,656
	2	576	235	To PS2	576	235	To Wadi Al Arab PS2	Use Existing	0	560	355,656
	3	576	235	To PS2	576	235	To Wadi Al Arab PS2	Stand By	0	0	0
	4	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317,550
	5	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317,550
	6	567	220	To PS2	567	220	To Wadi Al Arab PS2	Use Existing	0	500	317,550
	7	567	220	To PS2	567	220	To Wadi Al Arab PS2	Stand By	0	0	0
Total required flow from PS1 to PS2 equal 2800m^3/h											

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Wadi Al Arab PS2	1	666	250	To PS3	666	250	To Wadi Al Arab PS3	Use Existing	0	675	428,693
	2	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	3	666	250	To PS3	666	250	To Wadi Al Arab PS3	Stand By	0	0	0
	4	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
	5	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
	6	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
	7	567	216	To PS3	567	216	To Wadi Al Arab PS3	Use Existing	0	500	317,550
Total required flow from PS2 to PS3 equal 2800m^3/h											
Wadi Al Arab PS3	1	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428,693
	2	666	250	To Zubdat	666	250	To Zubdat	Use Existing	0	675	428,693
	3	666	250	To Zubdat	666	250	To Zubdat	Stand By	0	0	0
	4	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	5	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	6	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
	7	567	220	To Zubdat	567	220	To Zubdat	Stand By	0	0	0
					922	74	To Deir Al Saneh	New PS	637,154	315	199,825
					297	25	To Qumaym	New PS	205,244	34	21,746

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Qumaym PS					189	151	To Jamha	New PS	130,610	132	83,817
Jenin PS					123	146	To Ezimal	New PS	85,000	83	52,595
Ezimal PS					8	90	To Kufur Kifia	New PS	5,528	3	2,109
Dair Abi Said					557	73	Kufur Alma	New PS	384,919	188	119,087
Kufur Alma PS					377	212	To Al Ashrafiyya	New PS	260,528	369	234,080
					62	232	To Tubneh	New PS	42,846	66	42,128
Total required flow from PS3 to Zubdat equal 1234m^3/h											
Zubdat	5	300	190	To Hofa	300	190	To Hofa	Use Existing	0	290	184,179
	2	500	200	To Hofa	500	200	To Hofa	Stand By	0	0	0
	3	500	200	To Hofa	500	200	To Hofa	Stand By	0	0	0
	4	300	250	To Bani Kinana				Not to be used	0		0
	1	300	250	To Bani Kinana				Not to be used	0		0
					28	77	To Beit Yafa	New PS	19,350	10	6,314
					291	120	To Aydoun	New PS	201,098	161	102,273
					85	13	To Kufur Youba	New PS	58,740	5	3,236
Total required flow from Zubdat to Hofa equal 321m3/h											
Hofa	1	380	265	To Samad	380	265	To Samad	Stand By	0	0	0
	2	300	250	To Samad	300	250	To Samad	Use Existing	0	320	203,232
	3	200	250	To Samad	200	250	To Samad	Use Existing	0	225	142,898
					1724	230	To Samad	New PS	1,191,382	1,829	1,161,323
					401	109	To Al Hoson	New PS	277,114	202	128,014
					30	30	To Juhfiyya	New PS	20,732	4	2,636
Total required flow from Hofa to Samad equal 2224m3/h											

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Samad	3	300	250	To Ras Muneef	300	250	To Ras Muneef	Use Existing	0	420	266,742
	4	200	250	To Ras Muneef	200	250	To Ras Muneef	Use Existing	0	230	146,073
	1	100	200	To Al Mazar	100	200	Stand by	Use Existing	0	0	0
	2	150	250	To Al Mazar	150	250	Stand by	Use Existing	0	0	0
					1180	222	To Ras Muneef	New PS	815,447	1,208	767,225
					138	102	To Aseem	New PS	95,366	65	41,226
					8	44	Deir Al Birak	New PS	5,528	2	1,036
Total required flow from Samad to Ras Muneef equal 1680m^3/h											
WehdehPS0					4110	239	To Wehdeh PS1	New PS	2,840,244	4,530	2,876,919
Wehdeh PS1					4110	191	To Wehdeh PS2	New PS	2,840,244	3,621	2,299,609
Wehdeh PS2					4110	201	To Zubdat	New PS	2,840,244	3,810	2,419,501
Sama Arrousan PS					39	40.5	To Safouk	New PS	26,951	7	4,626
Tubneh Booster	1	50	300	To Tubneh				Not to be used	0	0	0
					62	219	To Tubneh	New Pumps	42,846	63	39,767
Al Nuaimeh PS					70	170	To Al Nuaimeh Up	New PS	48,374	55	34,853
Sal PS					196	32	Sal Tower	New PS	135,447	29	18,369

Table I-3b: Cost Estimates for Alternative 3 - Pump Stations and Annual Power Costs - Continued

Required Pump Station	Available Pumps				Required Pump Sets			Status	Cost Estimate,$	Power, KW	Power Cost,$
	No.	Q (m3/h)	H (m)	Destination	Q (m3/h)	H (m)	Destination				
Supplementary Sal Reservoir Pump	1				196	25	To Sal WT	New Pump	135,447	23	14,351
								Total Cost $	**17,320,650**		**20,382,829**

Table I-3c: Cost Estimates for Alternative 3 - Pipelines

DIAMETER	Actual Status		Total Pipe Length	Unit Cost, $/m	Total Cost,$
	Existing	New			
100	8,917	67,413	76,330	61.0	4,112,193
150	49,755	64,152	113,907	76.0	4,875,552
200	15,538	99,972	115,510	94.0	9,397,368
250	0	46,755	46,755	113.0	5,283,315
300	16,585	38,397	54,982	134.0	5,145,198
350	0	27,860	27,860	157.0	4,374,020
400	37,604	46,067	83,671	182.0	8,384,194
500	31,506	43,590	75,096	238.0	10,374,420
600	78,687	41,471	120,158	301.0	12,482,771
700	0	19,363	19,363	372.0	7,203,036
800	22,999	45,979	68,978	450.0	20,690,550
1000	0	25,906	25,906	617.0	15,984,002
1100	0	32,530	32,530	706.0	22,966,180
Grand Total	**261,591**	**599,455**	**861,046**		**131,272,799**